

## Larval Fish Entrainment at the Tracy Facility, Quantifying Spatial and Temporal Patterns of Distribution and Abundance

### Investigators

#### Michael J Horn

*Ecological Research and Investigations  
Bureau of Reclamation  
Denver, CO 80225  
mhorn@usbr.gov*

### Summary

With increasing interest being placed on the continuing declines of many fish species in the San Francisco Bay-Delta and associated San Joaquin and Sacramento River Systems, it is becoming more and more important to determine how operations of pumping facilities in the Delta might be impacting populations. Quantification of adults and larger juveniles of fishes entrained at the Tracy Fish Collection Facility (TFCF) is undertaken using a rigorous schedule of sub-sampling prior to fish being trucked to a release site (10-min counts). While larval fish are to some degree removed from inflow waters at the TFCF and trucked to release sites, species and numbers of fish <20 mm in length are not identified, counted, or measured by fish diversion workers. In the early 1990s Hiebert *et al.* (Hiebert *et al.* 1995, Siegfried *et al.* 2000) conducted several tests using a continuous pump sampler and plankton nets to determine the annual intake of larval fish to the TFCF. Weber *et al.* conducted a similar entrainment study upstream in the Sacramento River at the Red Bluff Diversion (Borthwick and Weber 2001). Hiebert *et al.* further compared their data to surveys conducted by California Fish and Game during their annual larval surveys and determined there was little correlation between the samples. This was likely due to the temporal and spatial differences between sampling locations. While valuable, Hiebert *et al.*'s study was conducted many years ago and was primarily designed to assess striped bass entrainment at the facility, as data had suggested population declines of striped bass were correlated to pumping plant activities (CDFG 1992). Hiebert also acknowledged their sampling procedure may not have encompassed much of the lateral variability in fish densities entering the facility due to the location of their sampling equipment.

It is recognized that since Hiebert *et al.* completed their study, fish populations in the Delta have changed significantly and these data are now likely out of date. As of yet there has been no concerted effort to assess the efficiency of the Tracy facility with respect to larval fish removal, and whether entrainment of larval fishes is a significant contributor to the decline of species in the Bay-Delta area. Larval fish population dynamics are becoming more of a concern in the Delta, and the presence of larval fishes near facilities could, in the near future, impact their ability to operate and/or require additional modifications to fish removal systems. Understanding the nature of the entrained larval fish community in terms of species, size, and age of fishes, and spatial and temporal differences in abundance will provide valuable information for managers

looking to avoid adverse impacts to operations associated with entrainment of larval fish. This study would complement other larval work already occurring in the Delta.

### **Problem Statement**

Larval fish samples are collected at the TFCF and surveys are conducted in the Delta to determine the presence of larval fish. Delta fish surveys show limited correlation to actual entrainment at the TFCF and with the exception of some past work, efficiency of larval fish removal at the facility has never really been addressed. Secondly, quantification of entrainment patterns and numbers of larval fish passing into the facility needs to occur. This study will provide information on facility efficiency; timing of entrainment; tidal, seasonal, diel and spatial dependency; and if operations impact the rate of entrainment. Such data will be useful in the future as an aid to determining operational impacts on population dynamics in the Delta, and to possibly further refine adjustments to operations as larval fish populations receive further scrutiny.

### **Goals and Hypothesis**

#### *Goals:*

1. Describe and quantify species and numbers being entrained at the facility.
2. Describe seasonality and spatial and temporal patterns of larval fish distribution in and around the facility.
3. Determine efficiency of larval fish removal.

#### *Hypotheses:*

1. If larval fish entrainment is affected by tide, time of day or season, then we would expect to see differences in larval fish distribution entering the facility.
2. If operations of Tracy or Clifton Court play no role in the number of larval fish entrained, then we would expect a uniform number of fish to be entrained when the action of those operations is accounted for.
3. If larval fish removal efficiency at Tracy is similar to that for larger sized fishes, then we would expect to see no difference in removal rates between size classes of fish.

### **Materials and Methods**

A sampling program will be developed around the use of 500-um entrainment nets at the entrance to the Tracy facility to determine the overall pattern of, and densities of larval fish entering the facility. Facility efficiency will be determined through comparisons of samples collected from the holding tanks where a 500-um screen will be overlain across the sample bucket to aid in retention of larval fish. Volume filtered will be standardized to the volume of water passing through the facility and compared to densities of fish collected from inflow waters (same methodology as used for the current 10-min counts [Karp *et al.* 1997, Sutphin *et al.* 2007]). In addition we will use data and

methodology from previous studies of larval entrainment to aid in developing the efficiency portion this study (Hiebert *et al.* 1995, Borthwick and Weber 2001, Siegfried *et al.* 2000).

Optimally drift nets will be placed upstream of the trashrack at a series of locations horizontally and vertically in the water column as determined by flow patterns entering the facility. We plan to use a series of nine net placements (3 x 3 array), three top, three mid-depth, and three bottom, with sites horizontally near either edge of the intake and near the middle. Deployment will consist of 500-um drift nets with attached calibrated flow meters. Based on preliminary unpublished data on debris entrainment, it is possible to attach nets off the boom upstream of the trashracks. Waterflow is more laminar, velocities are lower in this section, and flow is not yet impacted by mixing through the trashracks. The techniques of Borthwick and Weber 2001 will be used to normalize net data to account for zero counts on some net sets. A confidence interval constructed around the normalized distributions will be used to compare differences on a diel basis. A contingency table approach can be used to look at homogeneity of larval distribution across the sampling grid.

Temporal spacing of the sampling program will be designed to concentrate around seasons when larval fishes are known to be present in the system with less data being collected at other times (February–June). We will use current biological data available from the delta (larval surveys, current facility sampling) to determine the most appropriate sample times. Within this period we will focus on obtaining data to test differences in diel distribution, tidal impacts, impacts of operational changes, spatial differences and flow changes that might occur. It is anticipated a fairly significant effort will have to be placed upon sampling to ensure significant enough numbers of larvae are captured to ensure a degree of statistical power.

I plan to sample 1 week on, and 1 week off per month during the period of larval presence for up to 10 weeks of field data collection. While it is possible some pulses of fish will be missed there is an upper limit to the number of samples that can be effectively analyzed over the course of the study. Each trip one 24-h set will be accomplished at 6 sampling intervals (2 day, 2 night, 2 crepuscular) for a total of 56 samples per interval. A smaller subset of nets, namely the modified 10 min count will be sampled across the week to determine tidally and operationally related changes in fish densities. Samples will be preserved in formalin and stored for analyses after the end of the study period and early during FY 2011. A formal statistical plan will be submitted prior to starting the project.

Prior to developing a final study design we will need to conduct a site visit and do some initial deployments to determine the optimal placement of drift nets and to do a determination of types of data that may already be available, but may not have been analyzed to reflect the objectives of this study.

## **Coordination and Collaboration**

This study will be coordinated with TFCF staff, the Fisheries and Wildlife Resources Group, and the Ecological Research and Investigations Group. Close collaboration with Tracy staff will have to occur for help in initial identification of larval fish captured. I have past experience in identifying and sorting numbers of larval fish (Ph.D. dissertation) and anticipate learning to identify larval species in the Delta, and

being able to conduct most of the larval counts and analyses. This should minimize the time staff from Tracy are needed to assist in this study. Samples will be preserved and then be enumerated and identified during the off season. Close consultation will have to occur with operation staff concerning the mounting of nets at the facility to ensure there are no unforeseen technical difficulties and that all safety concerns are met. Coordination with a wider spectrum of groups will occur as data are collected, and if sufficient outside interest in the project develops.

Prior to the end of September 2009 (end of FY), I will make contact with personnel at Tracy to obtain necessary permissions to install equipment in the desired locations and to determine availability of staff to aid in the completion of the study.

### **Endangered Species Concerns**

There is significant potential for capture of larval stages of endangered or listed species. Permitting will have to be obtained to allow for potential take. Larvae captured during this study will already have been entrained by currents into the facility and would have been lost to the system regardless. A collecting permit will have to be obtained prior to commencement of this work

### **Dissemination of Results**

The primary deliverables will be articles published in the Tracy report series and if funding is available a peer-reviewed scientific journal. It is anticipated a poster and/or technical presentation and updates will be provided at TTAT, CVFFRT, and CHTR as well as at local scientific and agency meetings in the area. This knowledge will be useful in helping to guide future improvements in collection and operations of fish facilities.

### **Literature Cited**

- Borthwick, S.M., and E.D. Weber. 2001. *Larval fish entrainment by Archimedes lifts and an internal Helical pump at Red Bluff Research Pumping Plant, Upper Sacramento River, California*. Red Bluff Research Pumping Plant Report Series, Volume 12. U.S. Department of the Interior, U.S. Fish and Wildlife Service and Bureau of Reclamation, Red Bluff, California.
- California Department of Fish and Game (DFG). 1992. *A re-examination of factors affecting striped bass abundance in the Sacramento-San Joaquin Estuary*. WRINT-DFG-Exhibit 2 entered by the California Department of Fish and Game for the State Water Resources Control Board 1992 Water Right Phase of the Bay-Delta Fish Estuary Proceedings.
- Hiebert, S., C. Liston, P. Johnson, C. Karp, and L. Hess. 1995. *Continuous monitoring of fish eggs and larvae, 1991–1992*. Tracy Fish Collection Facility Studies, Volume 2. U.S. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.
- Karp, C., L. Hess, J. Lyons, and C. Liston. 1997. *Evaluation of the sub-sampling procedure to estimate fish salvage at the Tracy Fish Collection Facility, Tracy*,

*California, 1993–1996.* Tracy Fish Collection Facility Studies, Volume 8. U.S. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.

Siegfried, S., D. Craft, S. Hiebert, and M. Bowen. 2000. *Continuous monitoring of fish eggs and larvae at the Tracy Fish Collection Facility, Tracy, California, February–June, 1994.* Tracy Fish Collection Facility Studies, Volume 6. U.S. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.

Sutphin, Z.A., B.B. Bridges, B. Baskerville-Bridges, and R.C. Reyes. 2007. *Evaluation of current and historical 10-minute-count screens at the Tracy Fish Collection Facility, Tracy, California.* Tracy Fish Collection Facility Studies, Volume 31. U.S. Bureau of Reclamation, Mid-Pacific Region and Denver Technical Service Center.